EFFECT OF INSPIRATORY MUSCLE TRAINING ON PULMONARY FUNCTION IN LIVER TRANSPLANTATION PATIENTS

-A QUASI-EXPERIMENTAL STUDY

Dissertation submitted to The Tamil Nadu Dr. M.G.R. Medical University towards partial fulfillment of the requirements of **MASTER OF PHYSIOTHERAPY (Advanced PT in Cardio-Respiratory)** degree programme.

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CERTIFICATE

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This is to certify that research work entitled **"EFFECT OF INSPIRATORY MUSCLE TRAINING ON PULMONARY FUNCTION IN LIVER TRANSPLANTATION PATIENTS -A QUASI EXPERIMENTAL STUDY** was carried out by the candidate bearing the **Register No: 271430101**, KMCH College of Physiotherapy, towards partial fulfillment of the requirements of the **Master of Physiotherapy** (Advanced PT in Cardio-Respiratory) of The Tamil Nadu Dr. M.G.R. Medical University, Chennai-32.

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INTERNAL EXAMINER

EXTERNAL EXAMINER

Project Evaluated on:

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Objectives: To find out the effect of inspiratory muscle training on pulmonary function in liver transplantation patients.

Methodology: 16 liver transplantation patients were selected through purposive sampling technique and they were randomly assigned into control and experimental groups of 8 subjects each. Control group were treated with conventional chest physiotherapy and experimental group were treated with inspiratory muscle training along with conventional chest physiotherapy. Pulmonary function was assessed through Maximal inspiratory pressure (MIP), Maximal expiratory pressure (MEP) through modified sphygmomanometer, Peak expiratory flow rate (PEFR) through mini peak flow meter and 2Minute Walk Test.

Study setting: KMCH, Coimbatore.

Outcome Measures: MIP, MEP, PEFR and 2 MWT were taken once the patient transferred from ICU and the 15th post-operative day.

Results: The data were analyzed using paired‘t’ test and independent‘t’ test at 5% level of significance. Pre-test and post-test values are analyzed with Paired‘t’ test. There was significant difference within both the groups. The calculated t value for post test values of both the groups were 5.9, 5.7, 5.2, 5.3 for MIP, MEP, PEFR, 2MWT respectively. As the calculated value is greater than the table value, it is proved that there was significant difference between Group A and Group B. When the mean values are compared, Group B had a greater improvement than Group A.

Conclusion: Inspiratory muscle training along with conventional chest physiotherapy is effective in improving pulmonary function in liver transplantation patients.

Keywords: Maximal inspiratory pressure, Maximal expiratory pressure, peak expiratory flow rate, Threshold inspiratory muscle training.

INTRODUCTION

1. INTRODUCTION

Liver failure is a life threatening disease. Life would be troublesome if the liver function is reduced. There is a high rate of mortality in impaired liver function. In such a case, the only way to lead a life is by the transplantation of liver. The primary need for the liver failure patients is a liver which makes the patient to wait for a longer time, though they have enough money. The secondary requirement is that, the liver should be appropriate and suitable for the patients to get transplanted.

Pre-operative, peri-operative and post-operative complications are greater in liver transplantation. Pre-operative, peri-operative complications influence the post-operative complications such as cardio vascular diseases, vascular complications, hypertension, diabetes, malignancy, non-Hodgkin's lymphoma, non- melanoma skin cancer, neurological impairments recurrent HCV infections. Pulmonary function decreases due to the following reasons, the extensive surgical field which requires the transaction of abdominal oblique and rectus muscles, lengthy operating time during which the right diaphragm is kept retracted resulting in diaphragm dysfunction which can result in causing chest wall movement anomalies and 50-60% reduction in vital capacity and 30% reduction in functional residual capacity and even diaphragm paralysis.

Intra operative fluid over load and the effects of anesthesia can also affect the pulmonary functions, such as lung compliance and alveolar gas exchange. Due to the inhibitory effect of wound pain, they will have inadequate inspiration, coughing and mucous removal which can significantly contribute to the related morbidity and mortality

Post-operative complications include diaphragm dysfunction, chest wall anomalies, reduced muscle strength, muscle power, muscle girth, low bone mineral density, increased level of fatigue, reduced vital capacity and functional residual capacity, reduced pulmonary function and aerobic capacity. They will have a progressive impairment of their fitness and aerobic capacity.

Aerobic capacity is the ability of the body to consume and use oxygen during exercise which is reduced in liver transplant patients. This is reflected by the close

association of altered musculature, dyspnea, and reduced exercise tolerance which leads to reduced aerobic capacity and quality of life with the high risk of mortality.

There is a high risk of respiratory failure in liver transplantation and it leads to requirement of reintubation. This increase the length of ICU stay, hospital stay, etc.. This results in mental stress, financial need, and more infections due to prolonged hospital stay.

Therefore, it is necessary to give more attention during the early post-operative period. There are numerous physiotherapy techniques such as, Diaphragmatic breathing exercise, lung expansion exercises, forced expiratory technique, incentive spirometry, autogenic drainage, ACBT, manual techniques, chest percussion and vibration, has been used for increase lung expansion, restore pulmonary function and prevent post-operative pulmonary complications.

The respiratory muscle pump is vital for the movement of air to the level of gas exchange in the respiratory system. The respiratory muscle include the diaphragm along with the strength of abdominal and intercostals muscles. Impairment in respiratory muscle pump compromises ventilation, gas exchange and tissue respiration where the load on respiratory muscles is increased, respiratory muscle capacity is reduced, it will lead to respiratory muscle weakness.

Pulmonary function can also be improved through training the respiratory muscle. Specific inspiratory muscle training would increase the inspiratory muscle strength and endurance. This is associated with decreased dyspnea and increased aerobic capacity. Dyspnea occurs due to increased work of breathing and reduced respiratory muscle strength which reduces aerobic capacity of the patient. It is well established that respiratory muscle can be trained like other skeletal muscles.

This respiratory muscle training would be given through the threshold inspiratory muscle trainer (IMT). It is a type of resistive training that strengthens respiratory muscles. IMT is a commercially marketed small held device which provides consistent and specific pressure setting (in cm H2O). It includes a mouthpiece and a calibrated spring loaded valve. The patient must generate the inspiratory pressure in order for the inspiratory valve to open and allow inhalation of air. The pressure would be measured with the help of Modified sphygmomanometer

which consists of well fitting mouthpiece connected to the upper and lower end of the capillary of the device for recording the peak inspiratory and expiratory pressures respectively.

Respiratory muscle strength is measured as Maximal inspiratory pressure (MIP), Maximal expiratory pressure (MEP). MIP is a measure of inspiratory muscle strength, MEP is the strength of abdominal and intercostals muscles. These are the simple tests in which patients generate as much as possible pressure against a blocked mouthpiece. Aerobic capacity would be measured through two-min walk test.

The aim of this study is to find out the effectiveness of inspiratory muscle training on pulmonary function in liver transplantation patients.

2. REVIEW OF LITERATURE

Respiratory complications following liver transplantation are the major causes of morbidity and mortality and the greatest increase in mortality occurs in the first three months after transplantation. Improvement in the pulmonary function may decrease the respiratory complications in these patients.

2.1 LIVER TRANSPLANTATION:

Liver transplantation is the replacement of the diseased liver with a healthy liver. It is the viable treatment for the end stage liver disease.

J M.Neuberger, Bridget K Gunsonet al., conducted a retrospective study on "Referral of patients with primary biliary cirrhosis for liver transplantation" with 107 patients between April 1981 and January 1989. They stated that the patient undergoing liver transplantation experience the good quality of life with 80% of one year survival rate[22].

2.2 COMPLICATIONS OF LIVER TRANSPLANTATION:

GiacomoGermani, Kryssia Rodriguez et al., conducted a study on "Markers of acute rejection and graft acceptance in liver transplantation". They stated that the acute rejection was the most common complications after liver transplantation due to immunosuppression[9].

Kin Pan Au, See-Ching Chan et al., organized a retrospective study on "Clinical factors affecting rejection rates in liver transplantation" with 788 patients from October 1991 to December 2011. They reported that the risk of rejection was based on the individualized immune suppression level and the morbidity level was increased in recipient[16].

Sheiner, Patricia et al., executed a study on "Late- term medical complications in patients surviving > 5 years after liver transplant" with 139 patients who underwent liver transplantation. They reported that the prevalence of

hypertension, diabetes, malignancy, non-hodgkins lymphoma, non- melanoma skin cancer was significantly higher[28].

Iscar, M et al., did a study on "Functional capacity before and after liver transplantation". They stated that the aerobic capacity was reduced in liver transplantation patients[11].

David J Bronster, SukruEmre et al., did a study on "Central nervous system complications in liver transplant recipients- incidence, timing, and long- term follow up" with 463 patients. They stated that the neurological impairment was the major cause for the morbidity and mortality[6].

Paul wozney, Albert B. Zajko et al., administered a study on "Vascular complications after liver transplantation". They reported that the most common complication after liver transplantation was hepatic artery thrombosis[27].

Jatinder pruthi, Katherine A. Medkiff et al, organized a study on "analysis of causes of death in liver transplant recipients who survived more than 3 years". They found that the recurrent HCV infection was the most common cause for death[13].

William bernal, rosa martin-mateos et al., conducted a retrospective study on "Aerobic capacity during cardiopulmonary exercise testing and survival with and without liver transplantation for patients with chronic liver disease" with 399 patients who underwent CPET at the time of Liver transplant assessment for elective Liver transplantation. They have concluded that the patients who had a reduced Aerobic capacity and anaerobic threshold were associated with increased mortality rate due to the longer duration of the post transplant hospitalization[29].

Lisa B. van wagner, Brittany lapin et al., carried out a study on "high early cardiovascular mortality following liver transplantation", cardio vascular disease has a excess long term mortality after liver transplantation. They have reported that the cardio vascular disease was the leading cause for death after liver transplantation followed by infection and graft failure. Mortality rate correlates with the age, pre-operative hospitalization, ICU status, MELD score, portal vein thrombosis, national organ sharing, donor BMI and cold ischemic time[18].

K.D.S Watt, R. A. Pedersen et al., did a study on "evolution of causes and risk factors for mortality post liver transplant: results of the NIDDK long term follow up study". They concluded that the liver related deaths accounted for almost one-third of all deaths due to post transplant diabetes, hypertension and renal insufficiency[30].

LucileneRezendeAnastacio R.D et al., conducted a study on "metabolic syndrome after liver transplantation: Preventable illness or common consequences". They concluded that the metabolic syndrome developed during early post operative period[17].

Pieber K et al.,did a study on "Aerobic capacity, muscle strength and health related quality of life before and after orthotopic liver transplantation: preliminary data of an Australian transplantation centre". They stated that the patients had a reduced physical performance and reduced quality of life before and after liver transplantation[26].

James M. Prentis et al., conducted a study on "Sub maximal cardiopulmonary exercise testing predicts 90- day survival after liver transplantation". They concluded that the anaerobic threshold level was reduced in liver transplantation patients[14].

2.3 PULMONARY COMPLICATIONS:

Paolo feltracco, Cristiana carollo et al., organized a mini review study on "Early respiratory complications after liver transplantation". Orthotopic liver transplantation is an only definitive treatment for patients with end stage liver cirrhosis. Mortality rate is very high in liver transplantation due to reduced pulmonary function[24].

Federico barbariol, luigivetrugno et al., did a case study on "Point of care ultrasound of the diaphragm in liver transplant patients with acute respiratory failure" fifty year old male with 60 kg develop an acute respiratory failure with dyspnea, hypoxia, tachypnea, hypercapnia. They reported that the acute respiratory failure was due to the preexistent diaphragm paralysis which is caused by the combination of abdomen surgery and general anesthesia.[7]

2.4 ASSESSMENT:

2.4.1 MIP, MEP, PEFR:

Costa D, Gonclaves HA et al., carried out a study on "New references values for maximal respiratory pressure in Brazillian population". They found that the PI_{max} was a measure of inspiratory muscle strength, whereas PE_{max} measures the strength of abdominal and intercostals muscles[5].

Dr.M.Joshi, Dr.N.Mathur et al., organized a prospective study on "pulmonary functions and effect of incentive spirometry during acute and post acute period in tetraplegia" at the department of physical medicine & rehabilitation, S M S hospital, Jaipur. At the end of the training session, the group who received incentive spirometry had a significant improvement in the peak inspiratory, expiratory mouth pressure which was measured with the help of modified sphygmomanometer and the cough peak expiratory flow rate was, measured by "Vitalograph". This shows that the pulmonary function can be assessed with the help of modified sphygmomanometer[12].

A.Gopalakrishna, K. vaishali et al., carried out a study on "Normative values for maximal respiratory pressures in an Indian mangalore population: A cross sectional pilot study.They have concluded that PI_{max} normal value for male was $75\pm$ 20 cm H_20 and for PE_{max} was 93 ± 33 cm H_20 and for PI_{max} in females was $48\pm$ 16 cm H_20 and for PE_{max} was 60 ± 20 cm H_20[8].

H.Hautmann, S. Hefele et al., did a study on "maximal inspiratory mouth pressure (PI_{max}) in healthy subjects- what is the lower limit of normal?" with 504 participants age between 18 and 83 years of age from January 1997 to may 1998. They have proved that the lower limits of the normal range were 60% of the predicted PI_{max} for men, and 59% for women[10].

2.4.2 TWO MINUTE WALK TEST:

Amy S.Y.Leung, Kam Keung Chan et al., conducted a prospective study on "Reliability, validity and responsiveness of a 2 min walk test to assess exercise capacity of COPD patients. They have proved that the 2MWT was a reliable, valid and more sensitive test to find out the exercise capacity and also it is a practical, simple, quick, easy to administer and well tolerated by the patient with moderate to severe COPD[1].

Brooks D, Parsons J et al., organized a study on "The two- minute walk test as a measure of functional capacity in cardiac surgery patients". They stated that the two minute walk test was sensitive to change after cardiac surgery and it strongly correlates with the quality of life[2].

2.5 TREATMENT:

2.5.1 PHYSIOTHERAPY IN LIVER TRANSPLANTATION:

Mericsenduran, ufukyurdalan et al., did a study on "Physiotherapy in liver transplantation" and proved that the pulmonary physiotherapy was essential to strengthen the respiratory muscle to reduce the pulmonary complications[21].

Cortazzo MH et al., organized a study on "Acute inpatient rehabilitation of 55 patients after liver transplantation". They concluded that the patients who have had liver transplants can achieve significant functional gains in acute rehabilitation[4].

Patrick Pasquinaet al., conducted a study on "Respiratory physiotherapy to prevent pulmonary complications after abdominal surgery: A Systematic review". They stated that the respiratory physiotherapy reduced pulmonary complications after abdominal surgery[25].

2.5.2 INSPIRATORY MUSCLE TRAINING:

Meralbosnak-guclu, hulyaarikan et al., carried out a study on "Effects of preoperative inspiratory muscle training in obese women undergoing open bariatric surgery: respiratory muscle strength, lung volumes, and diaphragmatic excursion" were measured with 32 obese women undergoing elective open bariatric surgery. After training the patients who received inspiratory muscle training had a significant improvement in the maximal inspiratory pressure[19].

SR Kulkarni, E Fletcher et al., conducted a pilot study on "Pre-operative inspiratory muscle training preserves postoperative inspiratory muscle strength following major abdominal surgery" with 80 awaiting major abdominal surgery. They

have proved that the inspiratory muscle training preserves maximal inspiratory pressure after abdominal surgery[15].

BC Brocki, JJ Andreasenet al., administered a study on "Post-operative inspiratory muscle training in addition to breathing exercises and early mobilization improves oxygenation in high-risk patients after lung cancer surgery". They stated that the inspiratory muscle training improved oxygenation and respiratory muscle strength after surgery[3].

Meral bosnak-guclu, hulyaarikan et al., organized a prospective, randomized controlled, double-blinded study on "Effect of inspiratory muscle training in patients with heart failure" with one thirty patients. They proved that the inspiratory muscle training improves the functional capacity, respiratory and peripheral muscle strength, functional balance, alleviates dyspnea and decreases depression in patients with heart failure[20].

Patielweiner, joseph waizman et al., conducted a study on "The effect of specific inspiratory muscle training on the sensation of dyspnea and exercise tolerance in patients with congestive heart failure" with twenty CHF patients. They have concluded that the Specific inspiratory muscle training increased respiratory muscle strength, endurance, sub maximal exercise performance and dyspnea level during daily activities in CHF patients[23].

2.6 SUMMARY:

The review of literature shows that there is an improvement in the pulmonary function and reduction in the respiratory complications after using chest physiotherapy among thoracic and abdominal surgical patients. Hence in this study it is necessary to find out the effect of inspiratory muscle training on pulmonary function using inspiratory muscle trainer along with chest physiotherapy among liver transplantation patients.

3. AIM AND OBJECTIVES

3.1AIM

- To find out the effect of inspiratory muscle training on pulmonary function in liver transplantation patients.

3.2 OBJECTIVES

- To determine the effect of conventional chest physiotherapy on pulmonary function in liver transplantation patients.
- To determine the effect of inspiratory muscle training on pulmonary function in liver transplantation patients.
- To implement into clinical practice.

4. MATERIALS AND METHODOLOGY

4.1 STUDY DESIGN: Quasi experimental study

4.2 POPULATION OF THE STUDY: 16 patients are selected and divided into 8 each in Group A and Group B

4.3 SAMPLING TECHNIQUE: Non- probability purposive sampling technique

4.4 DURATION OF THE STUDY FOR EACH PATIENT: 7 days

4.5 STUDY SETUP: KMCH, Coimbatore.

4.6 SELECTION CRITERIA:

4.6.1 INCLUSION CRITERIA:

- Patients who underwent liver transplantation
- Willingness to participate in the study
- Age between 35-60 years
- Both males and females are included.

4.6.2 EXCLUSION CRITERIA:

- Patients with neurological diseases
- Patients with cardiac and pulmonary disease
- Patients with multi organ failure
- Uncooperative patient
- Psychosis

4.7 NULL HYPOTHESIS:

H_{01} - There is no significant effect of conventional chest physiotherapy on maximal inspiratory pressure, maximal expiratory pressure, peak expiratory flow ratein liver transplantation patients

H_{02} - There is no significant effect of inspiratory muscle training along with conventional chest physiotherapy on maximal inspiratory pressure, maximal expiratory pressure, peak expiratory flow rate in liver transplantation patients.

H_{03} – There is no significant difference between effect of inspiratory muscle training along with conventional chest physiotherapy and conventional chest physiotherapy alone on maximal inspiratory pressure, maximal expiratory pressure, peak expiratory flow in liver transplantation patients.

H_{04} - There is no significant effect of conventional chest physiotherapy on 2 minute walk test in liver transplantation patients.

H_{05} - There is no significant effect of inspiratory muscle training along with conventional chest physiotherapy on two minute walk test in liver transplantation patients.

H_{06} - There is no significant difference between effect of inspiratory muscle training along with conventional chest physiotherapy and conventional chest physiotherapy alone on two minute walk test in liver transplantation patients.

4.8 PROCEDURE:

In order to keep everything sterile, mask, gloves, head cap, sterilized gown are used.

The treatment is given after getting concerned from the patient.

4.8.1ASSESSMENT OF STRENGTH OF RESPIRATORY MUSCLE:

The patient is assessed in half lying position. Nose will be closed with nose clip. Examiner places the tube which is connected with the modified sphygmomanometer on patient's mouth. The patient is advised to take a deep breath through mouth to find out the MIP and exhale maximum to find out the MEP. The tube is changed separately for each and every use.

4.8.2 ASSESSMENT OF PEAK EXPIRATORY FLOW RATE:

The patient is assessed in half lying position. Nose will be closed with nose clip. Examiner places the mouth piece of the device in the patient's mouth. The patient is asked to take a deep inhalation, and blows out forcefully and rapidly in a single exhalation. Measurement is taken three times and the best value is used for calculation.

4.8.3 ASSESSMENT OF 2 MINUTE WALK TEST:

Patient is advised to walk at their convenient speed for 2 minutes without any encouragement.

The patient is asked to walk back and forth in a 30 meter long corridor.

The examiner should walk behind the patient to minimize the effect of pacing.

The distance walked is measured after 2 minutes.

Patient is allowed to take rest as necessary as during the 2 minute period.

Distance walked (in meters), heart rate, blood pressure, oxygen hemoglobin saturation, perceived dyspnea using the modified Borg's scale, the number of rest taken and the duration of rests are monitored and recorded.

Readings were taken once the patient transferred from ICU and 15th postoperative day.

4.8.4 TREATMENT:

GROUP A: (CONTROL GROUP)

The subjects of this group totaling 8 treated with conventional chest physical therapyalone.

RELAXED DIAPHRAGMATIC BREATHING EXERCISE

Position of the patient: Half lying.

The patient is advised to sit comfortably and relax the shoulders and keep one hand on his upper abdomen and another hand on his chest. Then tell him to inhale

slowly through the nose and hold it for 10 seconds then exhale slowly through the mouth. Repetition 8 times (4 times, rest, 4 times)

INCENTIVE SPIROMETRY

Position of the patient: comfortable sitting.

The patient is asked to hold the incentive spirometry and place the mouthpiece in his mouth and advised him to breathe in slowly and to hold the breathe as much as he can. Then slowly exhale.

Repetition 8 times (4 times, rest, 4 times)

SPLINTED COUGHING:

Position of the patient: comfortable sitting with his chin slightly upward. The patient is advised to support the sutured site and breathe in slowly. Hold the breath for 2-3 seconds and force the breath out through his mouth in one quick burst of air. He should never cough to the point of exhaustion.

Perform 2 or 3 coughs, and then rest for 5 to 10 breaths.

Try to do 3 to 5 cycles of coughing and resting.

GENERAL MOBILITY EXERCISE:

Position of the patient: Initially sitting, and then gradually increasing to standing.

The patient is advised to do free exercises for all the joints of upper limb and lower limb. Shoulder–Flexion, extension, abduction, adduction and medial and lateral rotation. Elbow– flexion and extension. Fore arm – supination and pronation. Wrist – flexion, extension, radial deviation, ulnar deviation. Hip – flexion, extension, abduction, adduction internal and external rotation. Knee – flexion, extension. Ankle –Plantar flexion, dorsiflexion.

Repetition – 5 times, with adequate rest.

GENERAL ADVICES

- Care of the incision
- No lifting heavy objects
- No pushing or pulling of heavy objects
- No breath holding during exercise or while toileting
- No heavy arm exercises
- Modification of risk factors
- Avoid Valsalva maneuver

4.8.5 GROUP B (EXPERIMENTAL GROUP)

This group totaling 8 treated with inspiratory muscle training along with conventional physical therapy.

INSPIRATORY MUSCLE TRAINING:

Patient is explained about the training procedure.

Patient is positioned on 30^0 held up tilt in half lying position.

Maximal inspiratory pressure is measured and 30% of MIP is set as the resistance according to the patients MIP value.

Nose clip is used to close the nasal orifice.

The patient is asked to inhale against the resistance. Frequent rest period is given in between the session.

The progression is made after 3,4 days.

2 sessions per day and each session consists of 15 minutes training.

The training is given for 7 days.

This treatment is given once the patient transferred from ICU and 15^{th}post operative day.

4.8.6 PHOTOGRAPHIC PRESENTATION:

MIP, MEP MEASUREMENT:

PEFR MEASUREMENT:

IMT TRAINING:

4.9 OUTCOME MEASURES:

- Maximal inspiratory pressure (MIP)
- Maximal expiratory pressure (MEP)
- Peak expiratory flow rate (PEFR)
- 2 minute walk test.

4.10 MEASUREMENT TOOLS:

- Modified sphygmomanometer
- Stethoscope
- Stop watch
- Mini peak expiratory flow meter
- Inch tape

4.12 STATISTICAL ANALYSIS:

Independent "t" test (between groups)

$$t = \frac{\overline{X1} - \overline{X2}}{S} \sqrt{\frac{n_1 n_2}{(n_1 + n_2)}}$$

Where, $S = \sqrt{\frac{\sum d_1^2 + \sum d_2^2}{n_1 + n_2 - 2}}$

- **S** = Combined standard deviation
- $\mathbf{d_1}$ **&** $\mathbf{d_2}$ = difference between initial and final readings in group A & B
- $\mathbf{n_1}$**&**$\mathbf{n_2}$= number of samples in group A & group B
- $\mathbf{X_1}$**&**$\mathbf{X_2}$ = mean of group A & group B

Paired "t" test (within groups)

$$t = \frac{\bar{d}\sqrt{n}}{S}$$

Where, $S = \sqrt{\frac{\sum d^2 - [\bar{d}]^2 \times n}{n-1}}$

- n = Number of sample
- $\bar{d}$ = Mean of Deviation

Level of significance – 5 %

5. DATA PRESENTATION

5.1 TABULAR PRESENTATION

5.1.1 MAXIMAL INSPIRATORY PRESSURE (mmHg)

Independent‘t’ test

Mean	Pre-test		Post-test	
	Group A	Group B	Group A	Group B
	13.1	15.8	21.2	47.5
Calculated ‘t’ value	0.67		5.93	
P value and level of significance	p>0.05 and not significant		p<0.05 and significant	

Paired‘t’ test

Mean	Group A		Group B	
	Pre	Post	Pre	Post
	13.1	21.2	15.8	47.5
Calculated ‘t’ value	6.1		12.5	
P value and level of significance	p<0.05 and significant		p<0.05 and significant	

5.1.2 MAXIMAL EXPIRATORY PRESSURE (mmHg)

Independent‘t’ test

Mean	Pre-test		Post-test	
	Group A	Group B	Group A	Group B
	20.6	25.6	35	66.2
Calculated ‘t’ value	0.9		5.7	
P value and level of significance	p>0.05 and not significant		p<0.05 and significant	

Paired ‘t’ test

Mean	Group A		Group B	
	Pre	Post	Pre	Post
	24.3	35	25.6	66.2
Calculated ‘t’ value	9.3		14.7	
P value and level of significance	p<0.05 and significant		p<0.05 and significant	

5.1.3 PEAK EXPIRATORY FLOW RATE (lit/min)

Independent 't' test

Mean	Pre-test		Post-test	
	Group A	Group B	Group A	Group B
	168.7	175	222.5	368.7
Calculated 't' value	0.2		5.2	
P value and level of significance	p>0.05 and not significant		p<0.05 and significant	

Paired 't' test

Mean	Group A		Group B	
	Pre	Post	Pre	Post
	168.7	222.5	175	368.7
Calculated 't' value	4.6		18.6	
P value and level of significance	p<0.05 and significant		p<0.05 and significant	

5.1.4 TWO MINUTE WALK TEST (meters)

Independent‘t’ test

Mean	Pre-test		Post-test	
	Group A	Group B	Group A	Group B
	10.7	11.8	37.5	80
Calculated ‘t’ value	0.2		5.3	
P value and level of significance	p>0.05 and not significant		p<0.05 and significant	

Paired‘t’ test

Mean	Group A		Group B	
	Pre	Post	Pre	Post
	10.7	37.5	12.5	80
Calculated ‘t’ value	11.97		21.5	
P value and level of significance	p<0.05 and significant		p<0.05 and significant	

5.2 GRAPHICAL PRESENTATION:

5.2.1 MAXIMAL INSPIRATORY PRESSURE

Fig.1 PRE TEST MEAN OF GROUP A AND GROUP B

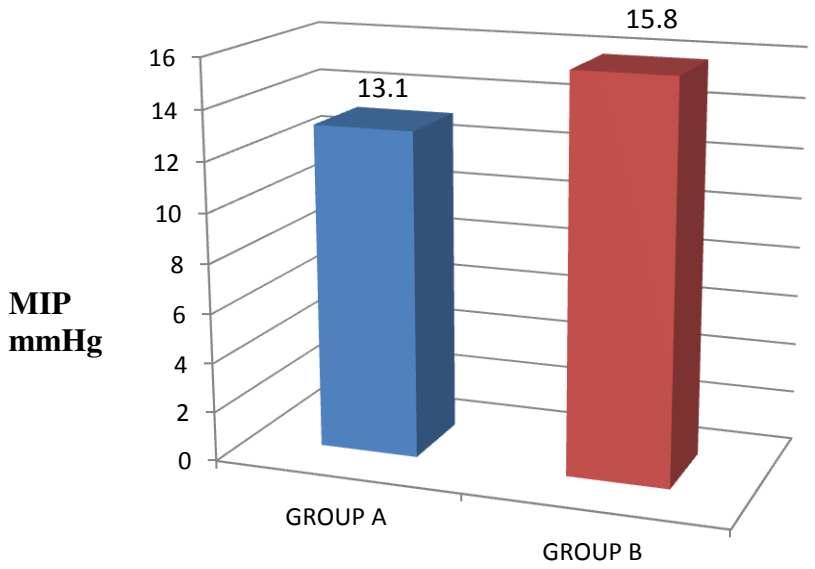


Fig.2 GROUP A PRE AND POST-TEST MEAN

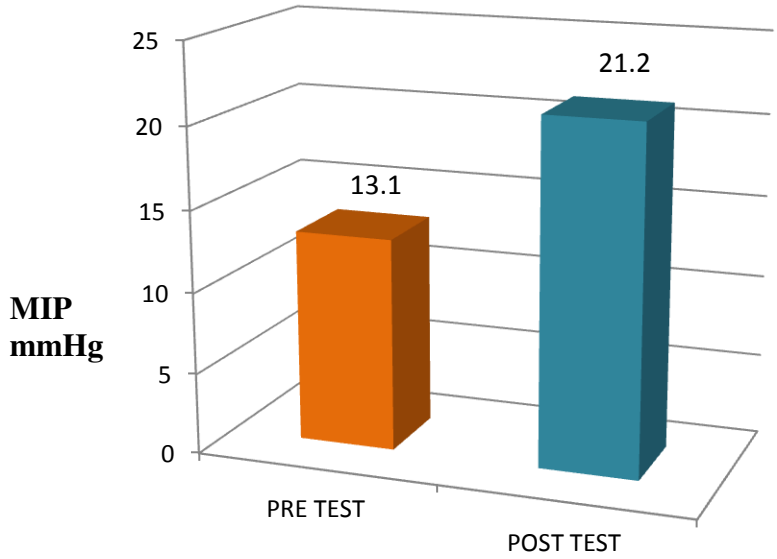


Fig.3 GROUP B PRE AND POST-TEST MEAN

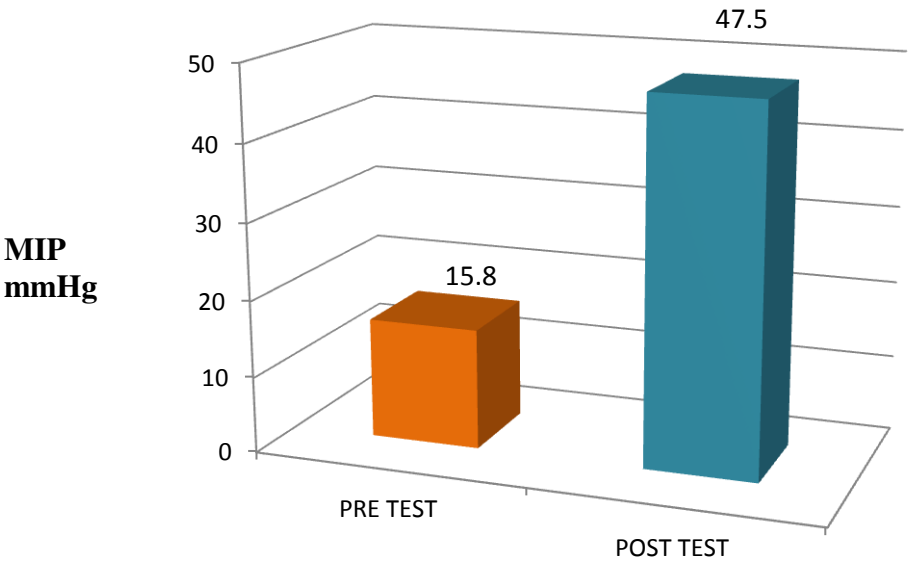
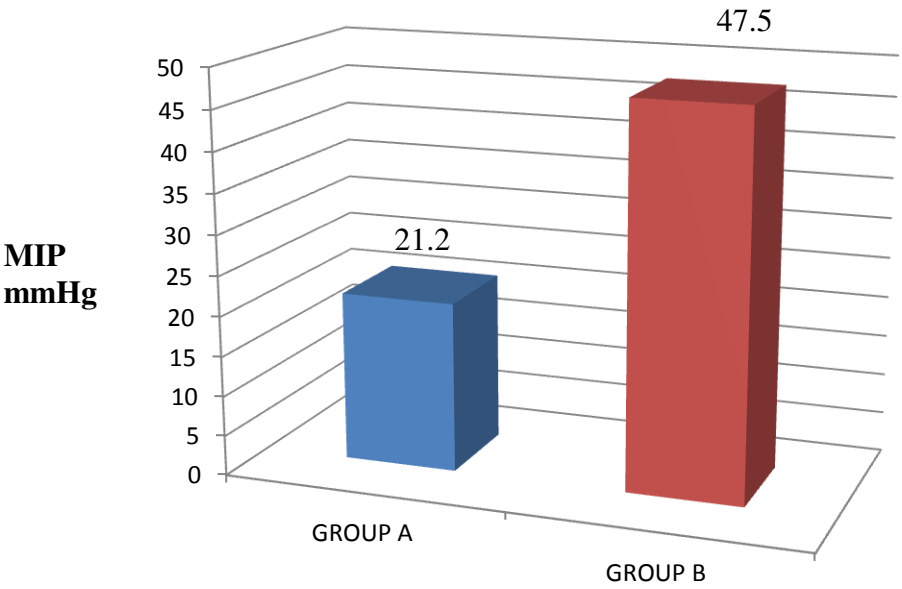


Fig. 4 POST-TEST MEAN OF GROUP A AND GROUP B



5.2.2 MAXIMAL EXPIRATORY PRESSURE

Fig.5 PRE TEST MEAN OF GROUP A AND GROUP B

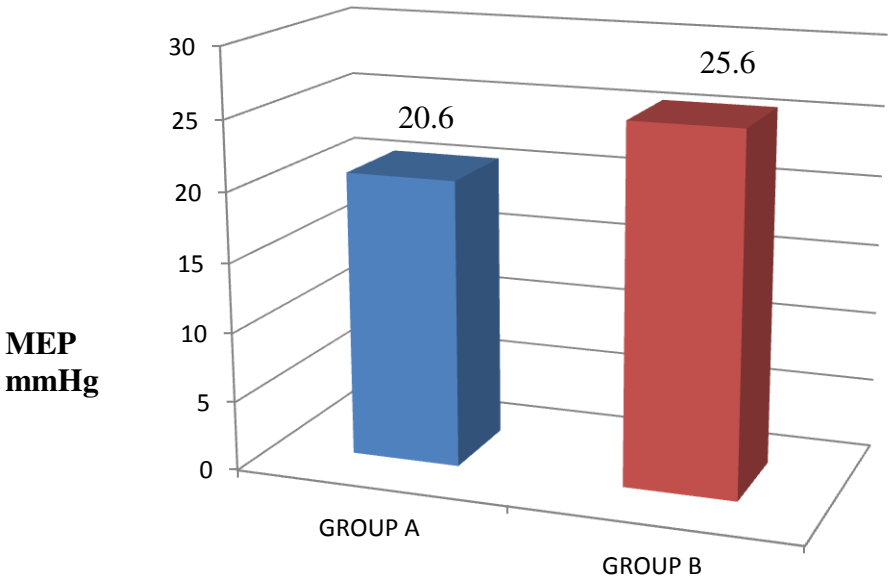


Fig.6 GROUP A PRE AND POST-TEST MEAN

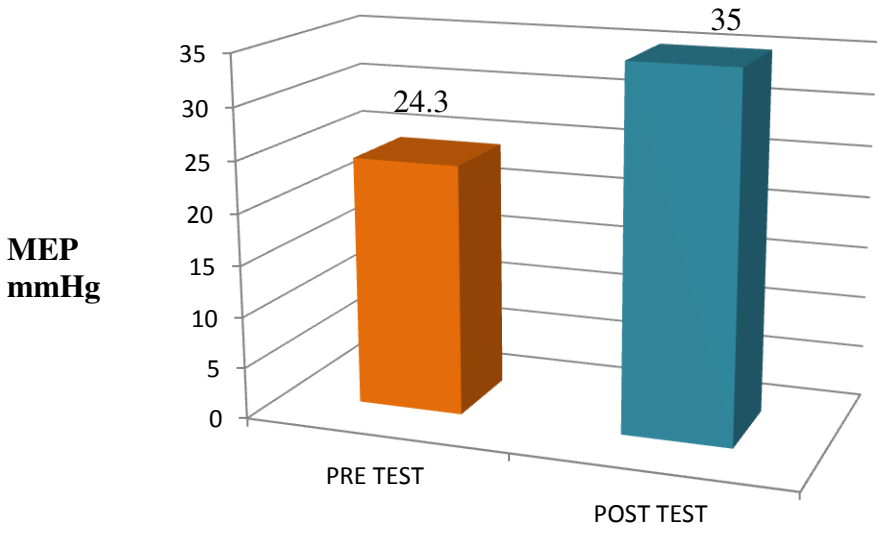


Fig.7 GROUP B PRE AND POST-TEST MEAN

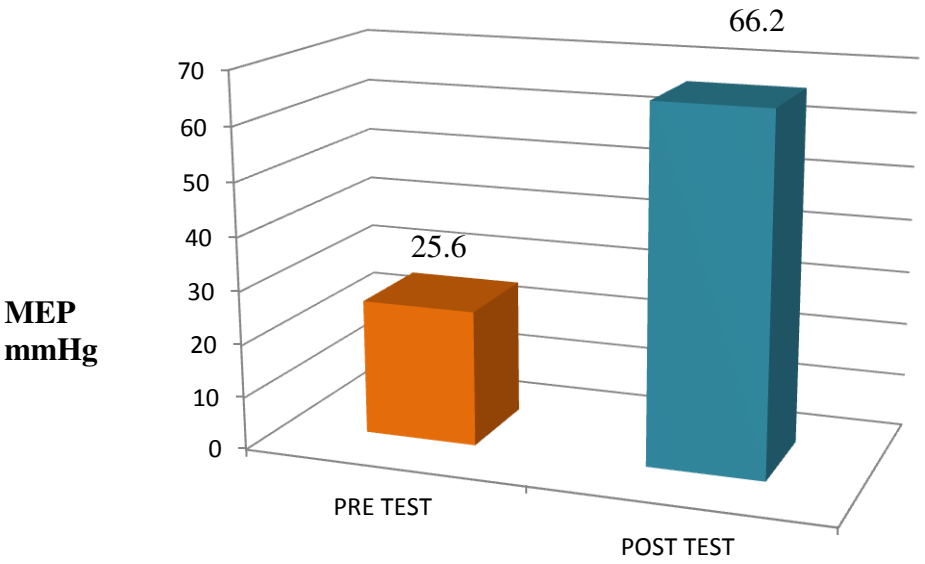
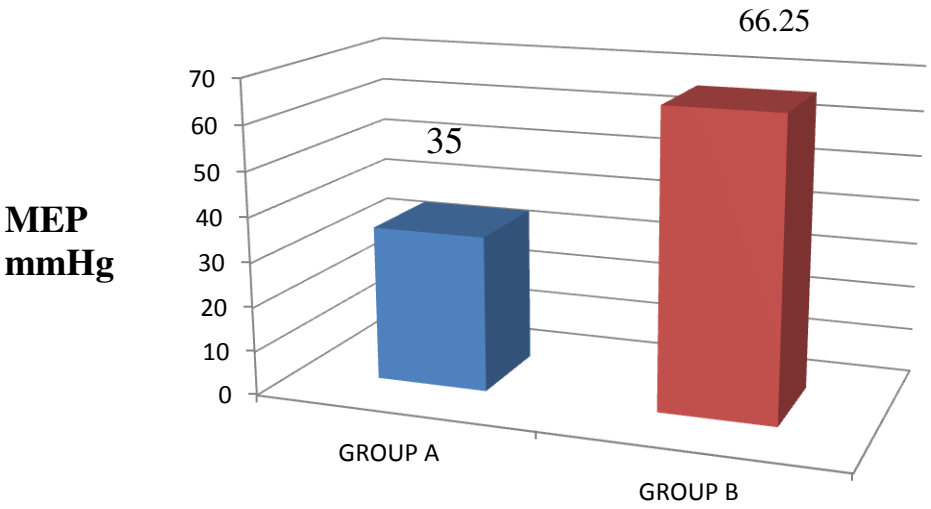


Fig.8 POST-TEST MEAN OF GROUP A AND B



5.2.3 PEAK EXPIRATORY FLOW RATE

Fig.9 PRE TEST MEAN OF GROUP A AND GROUP B

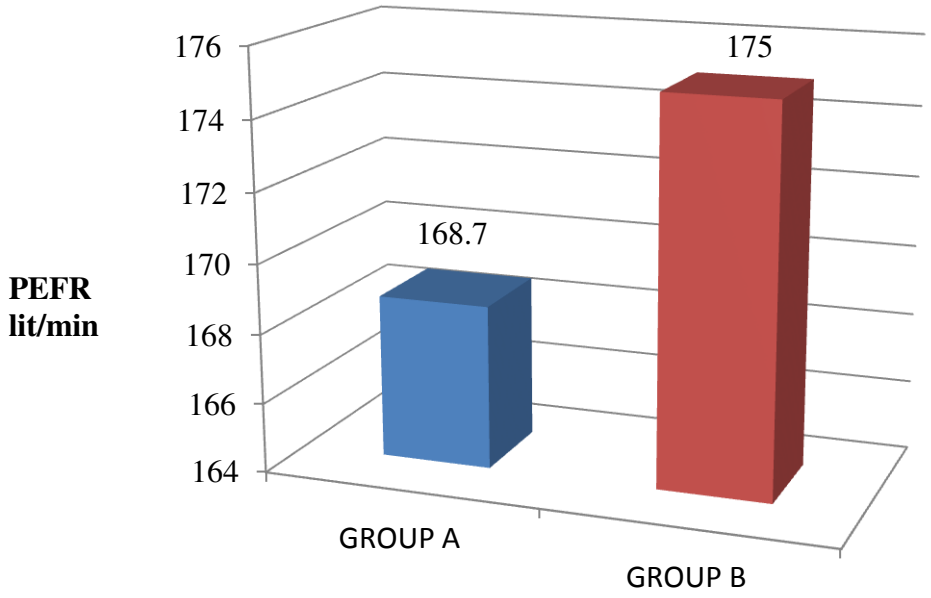


Fig.10 GROUP A PRE AND POST-TEST MEAN

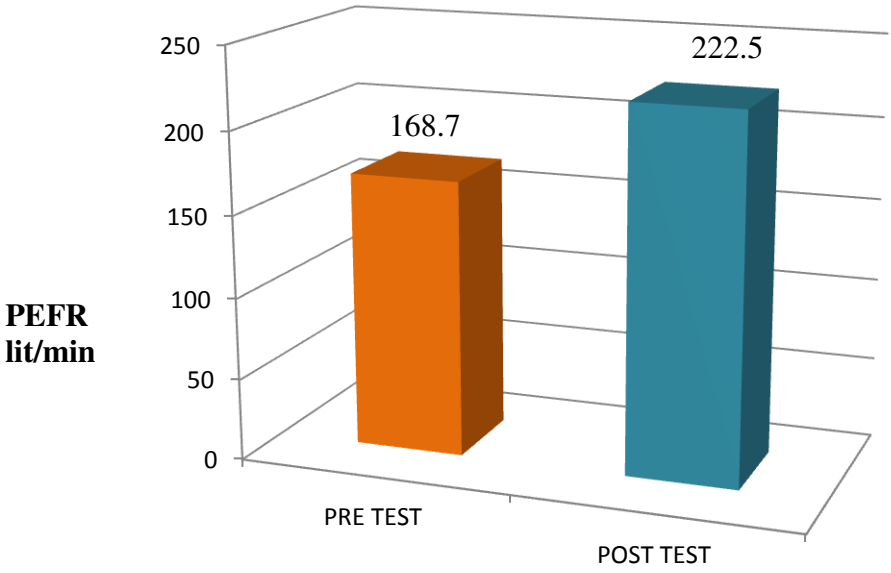


Fig.11 GROUP B PRE AND POST-TEST MEAN

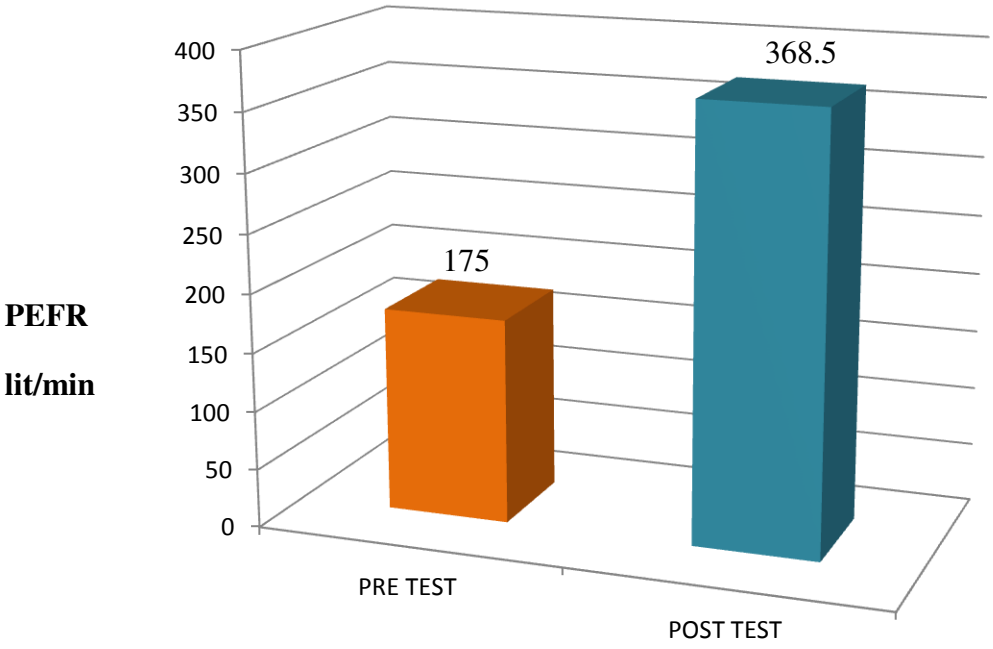
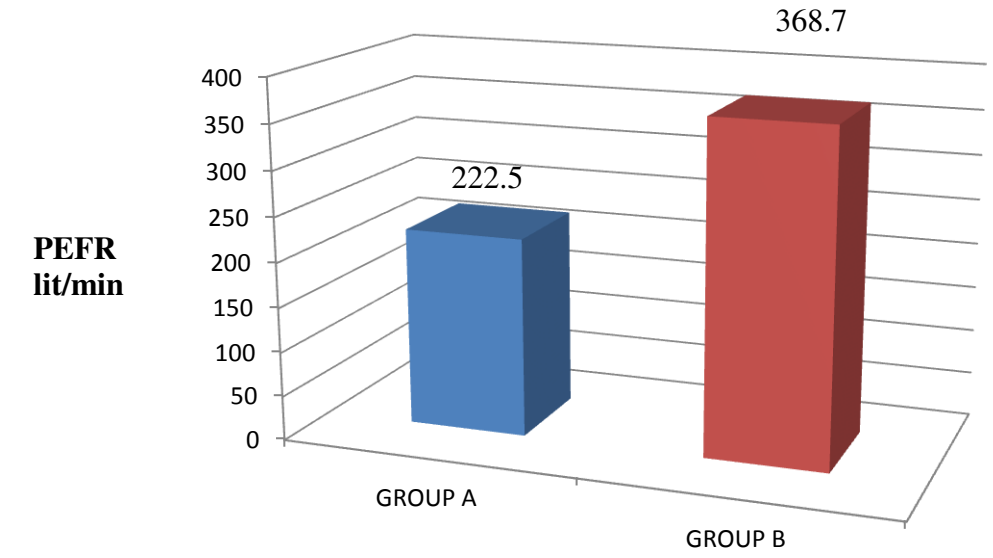


Fig.12 POST-TEST MEAN OF GROUP A AND B



5.2.4 TWO MINUTE WALK TEST

Fig.13 PRE TEST MEAN OF GROUP A AND GROUP B

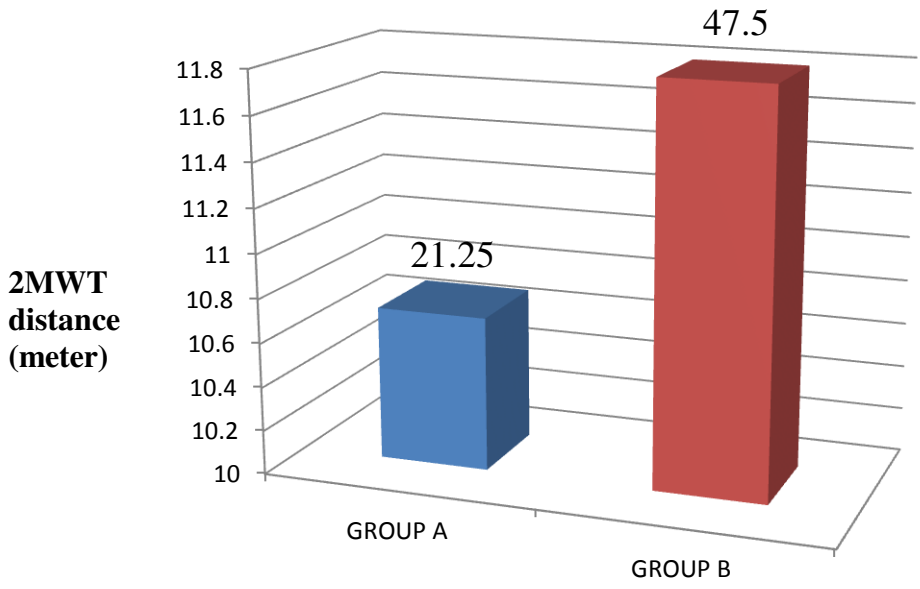


Fig.14 GROUP A PRE AND POST-TEST MEAN

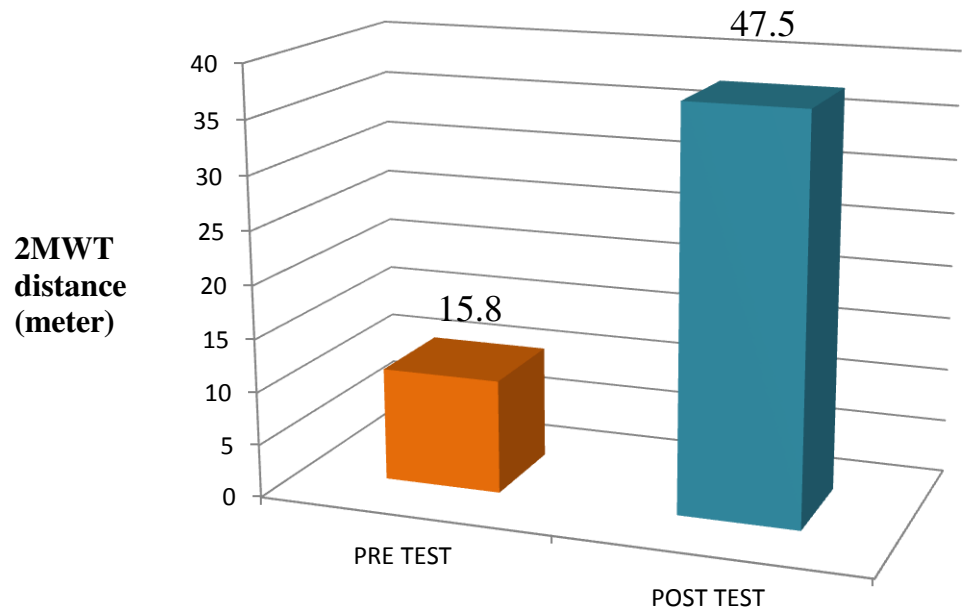


Fig.15 GROUP B PRE AND POST-TEST MEAN

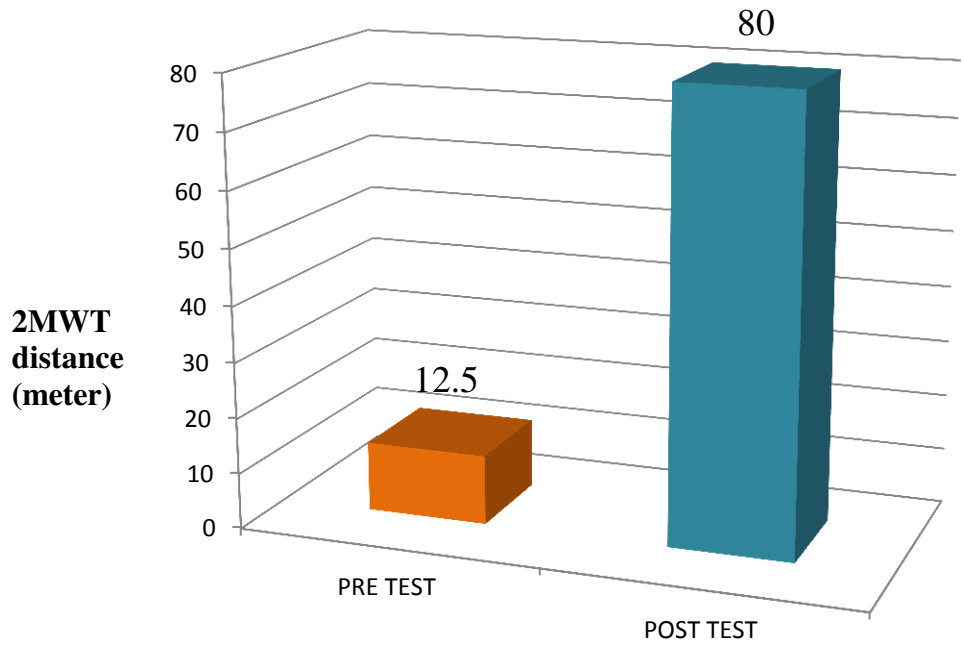
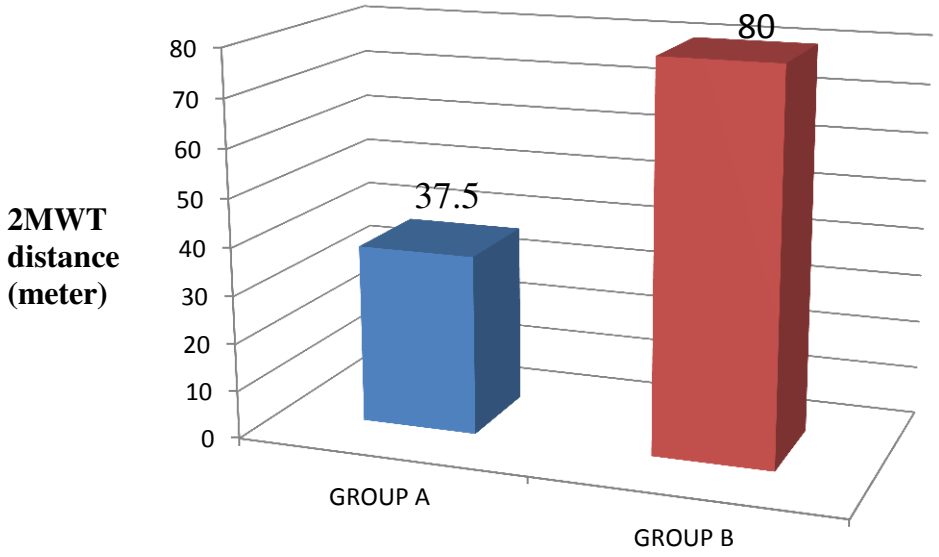


Fig.16 POST-TEST MEAN OF GROUP A AND B



6. DATA ANALYSIS AND RESULTS

6.1 MAXIMAL INSPIRATORY PRESSURE:

Pre-test value:

When the pre-test values of Group A and B were analysed by Independent 't' test, the calculated value was 0.6. For 14 degrees of freedom at 5 % level of significance, the table value is 2.145. It is proved that there is no significant difference between Group A and Group B. Thus homogeneity is maintained between two groups.

Group A:

When the pre-test and post-test values are analysed by paired 't' test the calclulated value is 6.1. For 7 degrees of freedom, at 5 % level of significance, the 't' value is 2.365. Since the calculated value is greater than the table value, null hypothesis H_{01} is rejected.

Group B:

For 7 degrees of freedom, at 5 % level of significance, the't' value is 2.365. The calculated 't' value between pre-test and post-test value is 3.493. Since the calculated value is greater than the table value, null hypothesis $H_{02}$is rejected.

Post-test value:

When the post-test values of Group A and B were analysed by Independent 't' test, the calculated value was 5.9. The table value for 14 degrees of freedom at 5 % significance is 2.145. It is proved that there is a significant difference between Group A and B and the null hypothesis H_{03} is rejected.

6.2 MAXIMAL EXPIRATORY PRESSURE:

Pre-test value:

When the pre-test values of Group A and B were analysed by Independent 't' test, the calculated value was 0.9. For 14 degrees of freedom at 5 % level of significance, the table value is 2.145. It is proved that there is no significant difference between Group A and Group B. Thus the homogeneity is maintained between two groups.

Group A:

When the pre-test and post-test values are analysed by paired 't' test the calculated value is 9.3. For 7 degrees of freedom, at 5 % level of significance, the 't' value is 2.365. Since the calculated value is greater than the table value, null hypothesis H_{01} is rejected.

Group B:

For 7 degrees of freedom, at 5 % level of significance, the 't' value is 2.365. The calculated 't' value between pre-test and post-test value is 14.7. Since the calculated value is greater than the table value, null hypothesis $H_{02}$is rejected.

Post-test value:

When the post-test values of Group A and B were analysed by Independent 't' test, the calculated value was 5.7. The table value for 14 degrees of freedom at 5 % significance is 2.145. It is proved that there is a significant difference between Group A and B and the null hypothesis H_{03} is rejected.

6.3 PEAK EXPIRATORY FLOW RATE:

Pre-test value:

When the pre-test values of Group A and B were analysed by Independent 't' test, the calculated value was 0.2. For 14 degrees of freedom at 5 % level of significance, the table value is 2.145. It is proved that there is no significant difference between Group A and Group B. Thus homogeneity is maintained between two groups.

Group A:

When the pre-test and post-test values are analysed by paired 't' test the calculated value is 4.63. For 7 degrees of freedom, at 5 % level of significance, the 't' value is 2.365. Since the calculated value is greater than the table value, null hypothesis H_{01} is rejected.

Group B:

For 7 degrees of freedom, at 5 % level of significance, the 't' value is 2.365. The calculated 't' value between pre-test and post-test value is 12.5. Since the calculated value is greater than the table value, null hypothesis $H_{02}$is rejected.

Post-test value:

When the post-test values of Group A and B were analysed by Independent 't' test, the calculated value was 5.2. The table value for 14 degrees of freedom at 5 % significance is 2.145. It is proved that there is a significant difference between Group A and B and the null hypothesis H_{03} is rejected.

6.4TWO MINUTE WALK TEST:

Pre-test value:

When the pre-test values of Group A and B were analyzed by independent 't' test, the calculated value was 0.2. For 14 degrees of freedom at 5 % level of significance, the table value is 2.145. It is proved that there is no significant difference between Group A and Group B. Thus homogeneity is maintained between two groups.

Group A:

When the pre-test and post-test values are analysed by paired 't' test the calculated value is 11.9. For 7 degrees of freedom, at 5 % level of significance, the 't' value is 2.365. Since the calculated value is greater than the table value, null hypothesis H_{04} is rejected.

Group B:

For 7 degrees of freedom, at 5 % level of significance, the 't' value is 2.365. The calculated 't' value between pre-test and post-test value is 21.5. Since the calculated value is greater than the table value, null hypothesis $H_{05}$is rejected.

Post-test value:

When the post-test values of Group A and B were analysed by Independent 't' test, the calculated value was 5.3. The table value for 14 degrees of freedom at 5 % significance is 2.145. It is proved that there is a significant difference between Group A and B and the null hypothesis H_{06} is rejected.

7. DISCUSSION

The incidence of liver failure has been increasing steadily due to the changes in the lifestyle of the recent generation. The liver transplantation is the only definitive and life changing treatment for the end stage liver failure. The most common complications of liver transplantations are the respiratory complications. The pulmonary complications occur in approximately 35-50% of liver transplantation patients.

Liver transplantation requires a large wide incision in the upper abdomen in which the abdominal oblique and rectus muscles are transected. It affects coughing due to the inhibited contraction of the abdominal muscles and also the right hemi diaphragm is retracted for a prolonged time which can result in weakness of the diaphragm muscle and decrease in VC 50-70%, FRC 30% which is the most common cause for pulmonary complications. These will result in reduction of the chest wall movement and inducing pain which inhibit the physical activity of the patient.

Meric senduran1 et al (2012), Paolo Feltracco et al (2013) have stated that the Physiotherapy plays a major role in prevention and treatment of these complications. Many techniques like deep breathing exercise, segmental expansion exercise, lung expansion exercise, ACBT, autogenic drainage can be used to provide airway clearance, increase lung expansion and restore the post operative pulmonary complication[21,24].

The purpose of this study is to find out the effect of Inspiratory muscle training along with conventional chest physiotherapy on pulmonary function in liver transplantation patients.

16 patients who had undergone liver transplantation surgery were selected by purposive sampling method. They were divided into two groups. The control group patients were received only conventional chest physiotherapy. The experimental group patients were received inspiratory muscle training along with conventional chest physiotherapy.

MIP, MEP, PEFR and 2MWT were used as outcome measures to evaluate the effect of physiotherapy treatment on pulmonary function in liver transplantation patients.

Hence, Group A with 8 samples were provided with the conventional chest physiotherapy including relaxed diaphragmatic breathing exercise, incentive spirometry, splinted coughing and general mobility exercises. There was statistically significant difference between the pre-test and post-test values of MIP, MEP, PEFR and 2MWT. The result showed a greater improvement in MIP, MEP, PEFR and 2MWT.

The result of the study correlates with the study done by **MeralBosnak et al.,**[20] , **Patrick Pasquina et al.,**[25]

Relaxed diaphragmatic breathing exercises have been used to eliminate accessory muscle activity, reduce the work of breathing, reduce the incidence of post-operative pulmonary complications, improve ventilation, strengthen the diaphragm and also it increased oxygenation and relief of dyspnea.

Incentive spirometry gave a visual feedback that encouraged slow and deep inspiration which helps to prevent pulmonary complications. It improved ventilation, oxygenation, reduced dyspnea level, increased tidal volume and reduced work of breathing.

Splinted coughing techniques was given to the patient to eliminate excessive retained secretions, to increase the positive pressure develops during cough, avoidance of cough complications, elimination of clinical signs of retained secretions and also for expectoration. This helped the patient to take a deep inspiration and also cough and expel mucous secretions. All these reasons lead to increased pulmonary function and exercise capacity and reduced pulmonary complications following liver transplantation patients.

When the mean values are compared Group B (experimental) had a greater improvement than Group A (control)

Inspiratory muscle training was given to the patient to increase the strength and endurance of the inspiratory muscles. IMT reduced dyspnea by improving respiratory muscle function and exercise tolerance.

The training response of respiratory muscle is similar to that of skeletal muscle. Training effects on pulmonary ventilation associated with decrease in rate and increased in tidal volume. One important difference is that strengthening exercises on inspiratory muscles may include increase in the size and number of the muscle fibers by an increased protein synthesis by the muscle fibres and a decrease in degradation. Resistance training of the inspiratory muscles is thought to promote an increase in the

proportion of fatigue- resistant fibers in the diaphragm, an increase in the metabolic capability of the muscle.

Improvement in the strength and endurance of the inspiratory muscles through training has the effect of enhancing the resistance to inspiratory muscle fatigue and improving ventilator function. Then the work of breathing reduced and respiratory reserves are increased.

All the patients gave a subjective feedback that there was no dyspnea during activity when compared before starting the treatment program and also it gave relaxation to the patients.

BC Brocki, JJ Andreasen et al., administered a study on "Post-operative inspiratory muscle training in addition to breathing exercises and early mobilization improves oxygenation in high-risk patients after lung cancer surgery". They stated that the inspiratory muscle training improved oxygenation and respiratory muscle strength after surgery[3].

The most successful findings have been attained using threshold inspiratory muscle training in congestive heart failure, thoracic and abdominal surgeries, in which several investigators have demonstrated significant and progressive improvement in respiratory muscle strength and functional capacity.

From this study, it may be concluded that the inspiratory muscle training along with conventional chest physiotherapy can be effective in liver transplantation patients to improve pulmonary function.

8. SUMMARY AND CONCLUSION

In order to find out the effect of inspiratory muscle training on pulmonary function in liver transplantation patients, this study has been conducted with two groups consisting of 8 patients each. Experimental group received inspiratory muscle training with conventional chest physiotherapy and control group received conventional chest physiotherapy.MIP, MEP, PEFR and 2MWT were taken after transferred from ICU and 15^{th} post-operative day.

Statistical analysis showed significant improvement in pre and post-test values of both the groups. There was a significant difference between the groups. The improvement is greater in the experimental group. Based on the results, it may be concluded that the inspiratory muscle training can be added to improve pulmonary function in liver transplantation patients.

9. LIMITATIONS AND SUGGESTIONS

- The sample size was small. Further studies can be done with large sample size.
- Study duration was shorter. Further studies can be done with longer duration.
- Length of hospital stay is not included. Further studies can be done with length of hospital stay.
- ICU stay and the treatment given in ICU was not assessed. Further studies can be done with ICU stay and the treatment given in ICU.
- Quality of life can be taken as a outcome measure in further studies.
- Dyspnea scale can be taken as a outcome measure in further studies.
- In this study Maximal inspiratory pressure, Maximal expiratory pressure is measured with modified sphygmomanometer. Further studies can be done with body plethysmography.

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APPENDIX 1

INFORMED CONSENT FORM

I ……. Voluntarily consent to participate in the study titled "**EFFECT OF INSPIRATORY MUSCLE TRAINING ON PULMONARY FUNCTION IN LIVER TRANSPLANTATION PATIENTS"**

The researcher has explained me about the study, possible risks & associated benefits of participation. The researcher has answered the question related to the study to my complete satisfaction.

SIGNATURE OF THE PARTICIPANT:

SIGNATURE OF WITNESS:

SIGNATURE OF THE RESEARCHER:

APPENDIX 2

ASSESSMENT FORM

Name:

Age:

Sex:

I.P No:

Date of surgery:

Group: Experimental/ Control

RR:

PR:

BP:

Outcome measures	Pre-test	Post-test
MIP (mmHg)		
MEP(mmHg)		
PEFR(lit/min)		
2MWT(distance)(meters)		

Contact Number: